A Fringe Projector Based study of the Brighter-Fatter Effect

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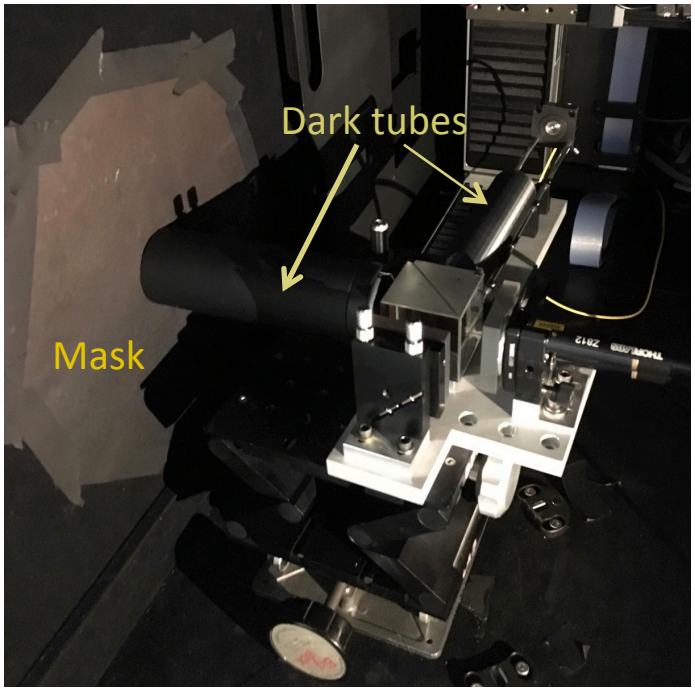
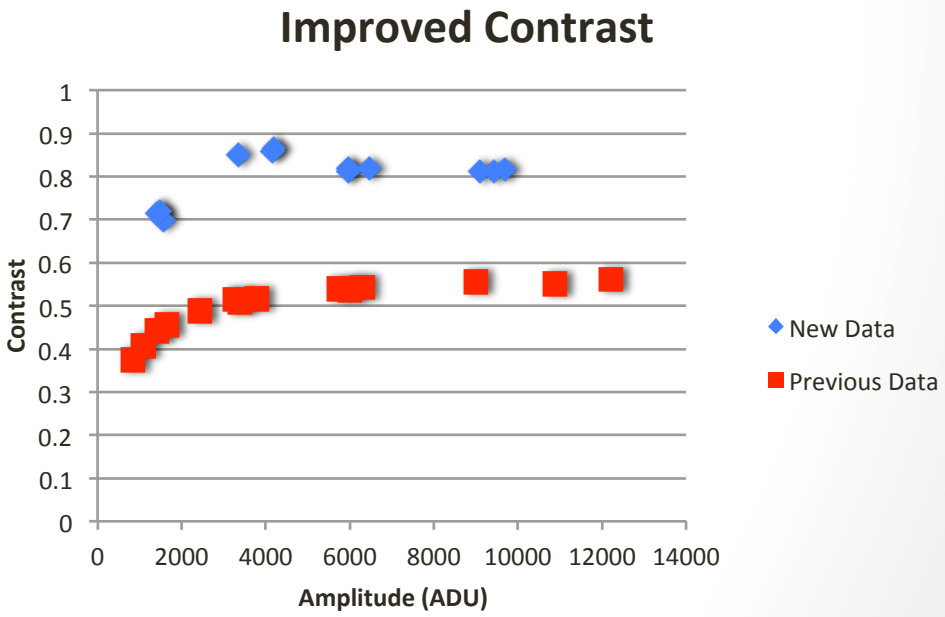
Recap

- Using an interferometer I projected fringes onto a CCD and demonstrated an asymmetry between peaks and troughs at higher intensities
- Problems with the lab setup caused lower contrast than expected as well as a drift changing the positions of the fringes by a few pixels
- The model for the Brighter-Fatter effect had trouble fitting the data

Improvements made to the lab setup

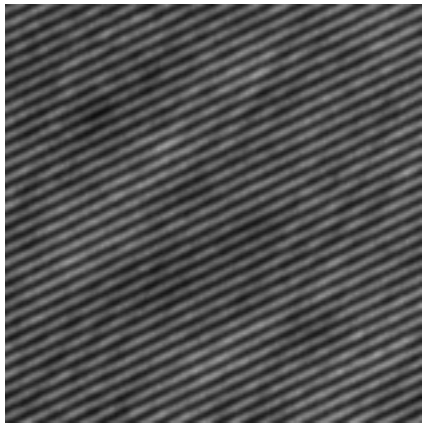
- Two dark tubes with flocking were added to the setup, along with a mask in front of the CCD

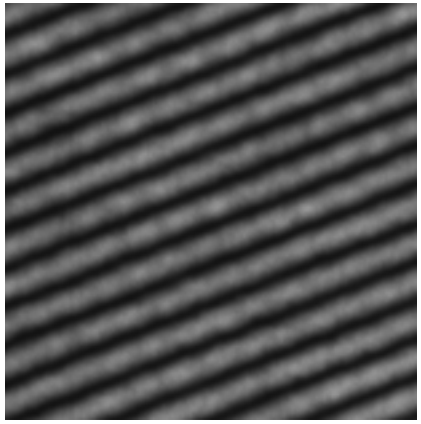


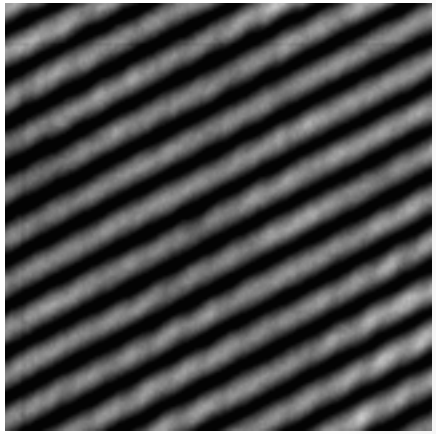


Additional data sets taken

- More data sets were taken at different periods to allow for investigations into how certain parameters correlate with the period







Modeling the Brighter-Fatter Effect

- The fringes can be modeled in one dimension using the following integral:

$$\rho(x') = \int_{-\infty}^{\infty} flux \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-x')^2}{2\sigma^2}} dx$$

- To account for the Brighter-Fatter Effect the PSF (σ) must depend on the flux:

$$\sigma = \sigma_o(1 + \delta \times flux)$$

- Both σ_o and δ determine the PSF. The fitter had a difficult time deciding if it should change δ or σ_o when fitting fringes

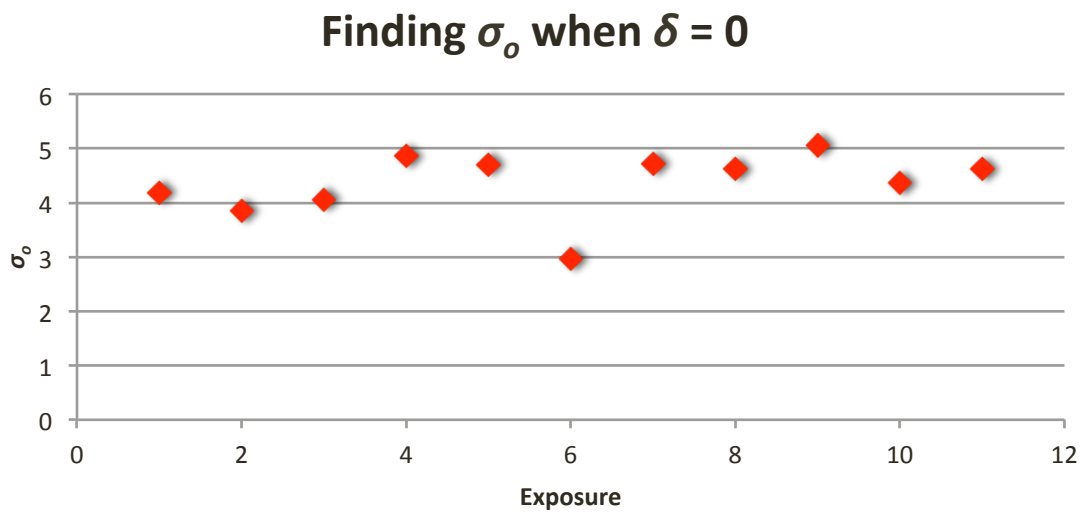
Modeling the effect

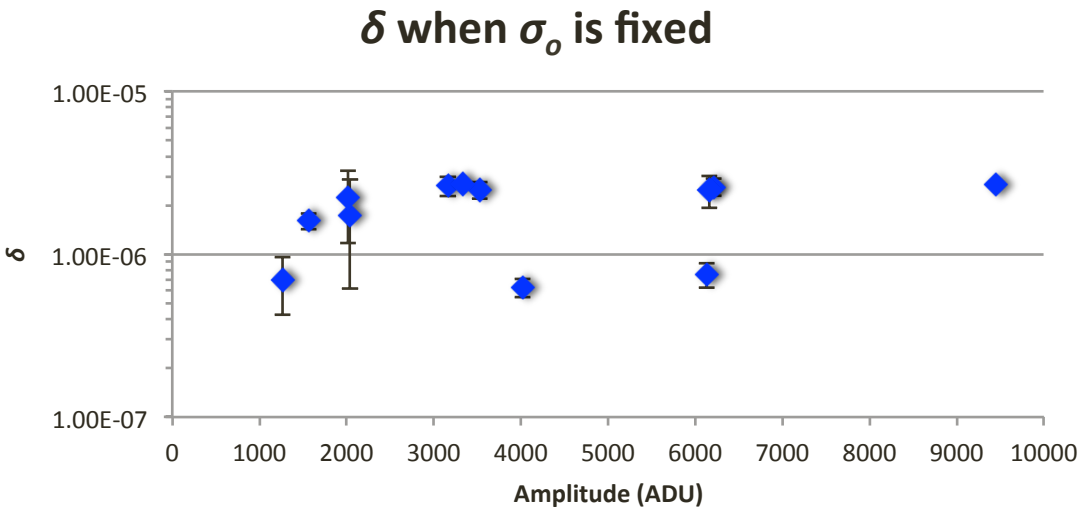
$$\sigma = \sigma_o(1 + \delta * flux)$$

- σ_o and δ should each be a constant, so to measure the brighter fatter effect I need to find σ_o
- By taking the shortest exposures and fixing δ = 0 I was able to get an estimate for σ_o
- Fixing this value in longer exposures while allowing δ to vary allows me to properly measure the brighter fatter effect

Results

$$\sigma = \sigma_o(1 + \delta \times flux)$$

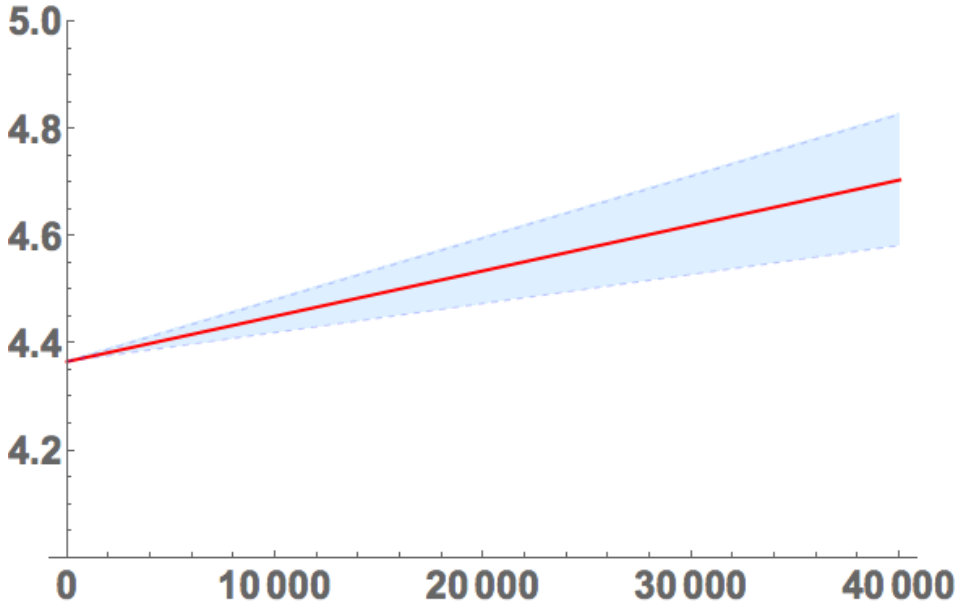




Results

- Plugging in the constant values for σ_o and δ into the equation gives a linear plot of the PSF (σ) changing with flux

$$\sigma = \sigma_o(1 + \delta \times flux)$$



- This shows a Brighter Fatter Effect of 7.76% +/- 2.8% which is consistent with previous experiments

Future work

- Correlation in the data need to be looked into (period vs delta, contrast vs sigma, etc.)
- Currently only one segment is being analyzed, this number can easily be increased with more time (gain has been measured and the corrections can be made)
- Edge roll-off appears to change the fringes as well, this could be another way to investigate that sensor effect